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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : H04R 11/00, 11/02

A1

(11) International Publication Number: WO 94/10817

(43) International Publication Date: 11 May 1994 (11.05.94)

(21) International Application Number: PCT/GB93/02140

(22) International Filing Date: 15 October 1993 (15.10.93)

(30) Priority data:
9222677.8 29 October 1992 (29.10.92) GB

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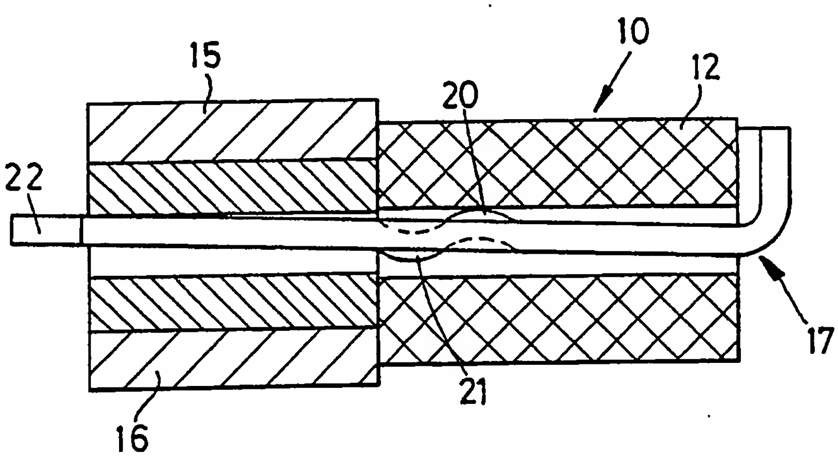
(81) Designated States: AU, CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: ELECTROACOUSTIC TRANSDUCER



(57) Abstract

This invention relates to electroacoustic transducers of the type which incorporate a reed armature. Thus a transducer (10) comprises a coil (12), magnets (13, 14), pole pieces (15, 16) and a reed armature (17), which passes through a central tunnel (18) defined the coil. A central portion (19) of the reed (17) lies within the tunnel and has opposed formation (20, 21) which limit the possible deflection of the reed (17). Other deflection limiting arrangements are described.

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Electroacoustic Transducer

This invention relates to electroacoustic transducers of the type which incorporate a reed armature.

An electroacoustic transducer of this general type is described in our British Patent 2095510, and typically includes a pair of spaced permanent magnets, a coil having a tunnel therethrough and a reed armature having a central portion which extends through the coil and a tip portion which lies at least partially between the magnets. The arrangement is such that when the moving part of the reed shifts in one direction or another away from a centralised position between the two poles, the magnetic flux is caused to flow in one direction or the other along the reed and hence through the coil. The reed is attached to a diaphragm and in this way the vibrations of the diaphragm caused by received sound are converted into corresponding currents in the coil or vice versa. It is very easy to damage the reed by over deflection, if the transducer experiences a shock e.g. from being dropped. In addition the tip portion may strike the magnet with considerable force. It will be understood that a similar configuration can be used for a receiver or loudspeaker.

In one transducer the coil tunnel has a restricted central portion which limits the degree of deflection available to the reed and hence reduces the possible damage. However because coils in such transducer are almost always formerless, this solution would apparently only be available

when the coil is set in epoxy having been wound on a flexible removable plastic former. This method of construction is only appropriate for certain types of transducer and has a number of limitations.

From one aspect the present invention consists in an electroacoustic transducer including a pair of spaced permanent magnets, a coil having a tunnel therethrough and a reed armature having a central portion which extends through the coil and a tip portion which lies at least partially between the magnets, the reed being mounted for deflection towards or away from the respective magnets, wherein the central portion and/or the tip of the reed is provided with a formation and/or a restriction is provided between the coil and the magnets, or at the magnet end of the tunnel, for limiting the available deflection of the reed.

In a particularly preferred embodiment there may be formations on each side of the reed and the formation or formations may be deformations in the reed. The formations are preferably on the central portion to reduce distortion of the magnetic field. Where the reed is flat and elongate, the formations are preferably formed by pressing out sections of the reed at or adjacent the longitudinal axis of the reed. By pressing, or otherwise deforming, the formation or formations from the reed, the limitation on the movement of the reed can be achieved without adding any mass to the reed, or indeed the transducer as a whole. However by restricting the formation or formations to the area of

the central axis of the reed, no additional restriction on the lateral position of the reed within the tunnel is introduced and extra restrictions on its rotational positions are limited. Further such formations can be pressed with considerable accuracy, which is important when the dimensions and tolerances involved are extremely small as is the case where the transducer is for use in a hearing aid.

In this construction the formation or formations may be semi-spherical, ridges or star shapes or a combination thereof.

In another arrangement the formation or formations may be constituted by a body or bodies mounted on the reed. For example the body may be in the form of a sleeve or may be in the form of some settable or deposited material or may simply be a body attached to the reed. These arrangements are somewhat less preferred, because they add weight to the reed and in the latter case the control of dimensions is more difficult. However, in certain cases, there may be advantages where the localised deformation of the reed undesirably affects its flexing properties.

In an alternative arrangement a restriction may be provided at or adjacent the end of the tunnel either by means of a spacer between the magnets and the coil with the restricted opening therein or in the form of an insert which can be pressed into the magnet end of the tunnel. In either case it is preferred that the restriction is constructed only to engage an area close to or adjacent the longitudinal

axis of the reed.

From another aspect the invention consists in an electroacoustic transducer including a pair of spaced permanent magnets, a coil having a tunnel therethrough and a flat elongate reed armature having a central portion which extends through the coil tunnel and a tip portion which lies at least partially between the magnets, the reed being mounted for deflection towards or away from the respective magnets, wherein the tunnel is defined solely by the windings of the coil and at least one part of the cross-section of the tunnel is dimensioned or shaped to restrict movement of the reed in a direction orthogonal to its plane.

The part may thus be narrower than the rest of the tunnel in the direction of reed movement or the tunnel may be formed with a formation or formations for engaging a part of the reed before the tunnel wall would otherwise be engaged by the reed. Preferably the formation or formations are in this case non-reentrant to avoid problems in winding the coil. For example the formations may cut off the corners of an otherwise rectangular cross-sectioned tunnel.

Although the invention has been defined above it is to be understood that it includes any inventive combination of the features set out above or in the following description.

The invention may be performed in various ways and specific embodiments will now be described in reference to the accompanying drawings, in which:

Figure 1 is a cross sectional stylised view through an electroacoustic transducer with the reed in its central

position;

Figure 2 shows the reed in its extreme upward position;

Figure 3 shows the reed in its extreme downward position;

Figure 4 is a view from above of the reed of the transducers Figures 1 to 3;

Figure 5 is a cross sectional view of the reed of Figure 4 along the line of IV - IV;

Figures 6 to 9 are schematic views generally corresponding to Figure 1 showing alternative arrangements; and

Figures 10 to 12 show a number of tunnel cross-sections for use in an alternative form of the invention.

An electroacoustic transducer 10 is schematically shown in Figures 1 to 3 and comprises a coil 12, magnets 13,14, pole pieces 15,16 and reed armature 17. As can be seen in Figure 1 the coil 12 defines a central tunnel 18 and the magnets 13,14 are spaced apart. The reed armature 17 extends along the tunnel 18 and between the magnets 13,14. A central portion 19 of the reed 17 lies within the tunnel 18 and, adjacent one end of that central portion 19, are formed opposed formations 20,21. As can be best seen in Figures 4 and 5 the formations 20,21 are generally semi-spherical and are pressed out of the plane of the reed.

As can be seen in Figures 2 and 3 the formations 20,21 respectively engage the coil 12 when the reed is deflected upwardly or downwardly beyond its normal working range. Preferably the formations are sized to prevent the tip 22 of

the reed 17 striking the magnets 13,14, but considerable protection can also be provided if they are dimensioned so that they strike the coil 12, before the tip 22 strikes either the magnet 13 or magnet 14.

It has been discovered that a transducer constructed in this manner can be dropped from, typically, twice the height, without incurring damage to the reed, as compared with an identical transducer without the formations. Put another way this means it can, typically, receive up to 4 times the shock without damage.

It will be appreciated that the formations could have other conventional shapes, but they are confined to the general area of the longitudinal axis of the reed 17 so that their existence introduces as little restriction as possible on the rotational or lateral position of the reed 17 within the tunnel 18. In a construction where this was not a factor, the formations could be at the sides of the reed 17 or extend right across it.

As has been explained above this construction has particular advantages; for example no extra mass is added to the reed 17. However many of the advantages of the invention can be obtained with other arrangements and these are briefly described in connection with Figures 6 to 9.

In Figure 6 the formations 20,21 are formed by blobs of adhesive or other settable material. In Figure 7 the formations 20,21 are formed by a sleeve 23 slid onto the reed 17.

Figures 8 and 9 show an another approach in which a

restriction is introduced either between the magnets 13,14 or the coil 12 or at the magnet end of the tunnel 18, so that the restriction engages the reed 17 to limit the deflection in a similar manner to that achieved by the formations mentioned above. Thus in Figure 8 a spacer 24 has a restricted opening 25 whilst in Figure 9 an insert 26 is pressed into the end of the tunnel 18 or created using settable plastic material. Preferably the restriction so created is confined to the area of the longitudinal axis for the reasons mentioned above.

A further approach is illustrated in Figures 10 to 12 in which the coil 12, which has its tunnel 18 defined purely by its windings, is wound in such a way that at least one part of its cross-section the tunnel walls are formed to engage the reed 17 in a way which reduces damaging deflections of the reed.

Thus in Figure 10 the coil 12 is wound with projections 27 projecting into the tunnel 18; in Figure 11, which is a longitudinal section of the coil 12, the tunnel has a reduced cross-section at 28 and in Figure 12 the corners of the rectangular tunnel 18 are cut off to provide inclined reed engaging surfaces 29.

It will be understood that the restriction principles recited in this description are applicable to many other reed mountings and configurations.

CLAIMS

1. An electroacoustic transducer including a pair of spaced permanent magnets, a coil having a tunnel therethrough and a reed armature having a central portion which extends through the coil and a tip portion which lies at least partially between the magnets, the reed being mounted for deflection towards or away from the respective magnets, wherein the central portion of the reed is provided with a formation on either side thereof and/or a restriction is provided between the coil and the magnet or at the magnet end of the tunnel for limiting the available deflection of the reed.

2. A transducer as claimed in Claim 1, wherein the formations are opposed deformations in the reed.

3. A transducer as claimed in Claim 2, wherein the reed is flat and elongate and the formations are formed at or adjacent the longitudinal axis of the reed.

4. A transducer as claimed in Claim 3, wherein the formations are pressed out of the plane of the reed.

5. A transducer as claimed in any one of Claims 1 to 4, wherein the formations are semi-spherical, ridges or star shaped or a combination thereof.

6. A transducer as claimed in any one of Claims 1 to 3, wherein the formations are constituted by a body or bodies mounted on the reed.

7. A transducer as claimed in Claim 6, wherein the body is in the form of a sleeve mounted on the reed.

8. A transducer as claimed in Claim 7, wherein the body is in the form of a lump of settable material deposited on the reed.

9. A transducer as claimed in Claim 1, wherein the restriction is constituted by an aperture defined in a spacer located between the coil and the magnets, the dimension of the aperture, the direction of deflection of the reed, being smaller than the corresponding dimension of the tunnel.

10. A transducer as claimed in Claim 1, wherein the restriction is provided by an insert mounted in the magnet end of the tunnel.

11. A transducer as claimed in Claim 9 or Claim 10, wherein the reed is elongate and the restriction is constructed to engage only area on or adjacent the longitudinal axis of the reed.

12. An electroacoustic transducer including a pair of spaced permanent magnets, a coil having a tunnel therethrough and a flat elongate reed armature having a central portion which extends through the coil tunnel and a tip portion which lies at least partially between the magnets, the reed being mounted for deflection towards or away from the respective magnets, wherein the tunnel is defined solely by the windings of the coil and at least one part of the cross-section of the tunnel is dimensioned or shaped to restrict movement of the reed in a direction orthogonal to its plane.

13. A transducer as claimed in Claim 12 wherein the

part is narrower than the rest of the tunnel in the direction of reed movement.

14. A transducer as claimed in Claim 12 wherein the tunnel is formed with a formation or formations for engaging a part of the reed before the tunnel wall would otherwise be engaged by the reed.

15. A transducer as claimed in Claim 14 wherein the formations are non-reentrant.

16. A transducer as claimed in Claim 15 wherein the formations cut off the corners of an otherwise rectangular cross-section tunnel.

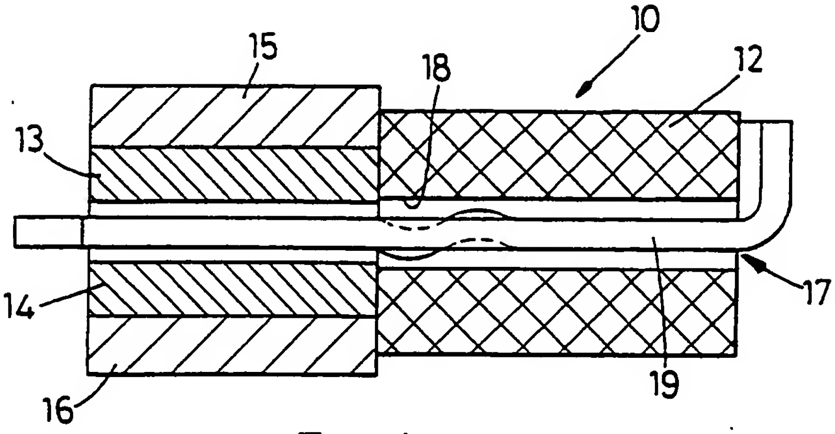

Fig. 1

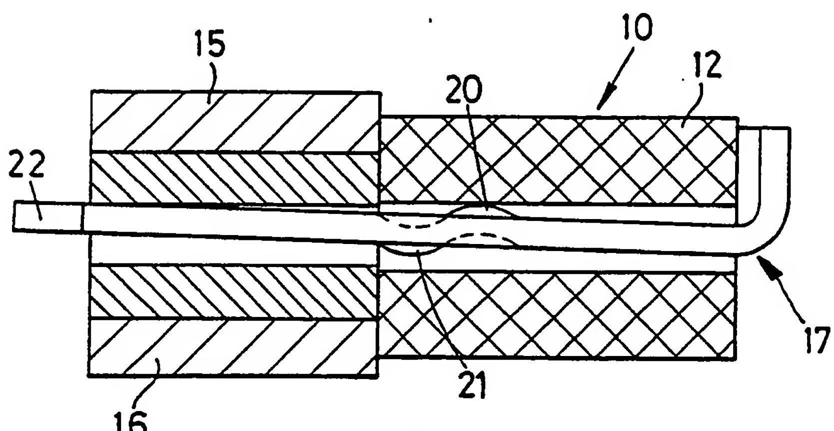

Fig. 2

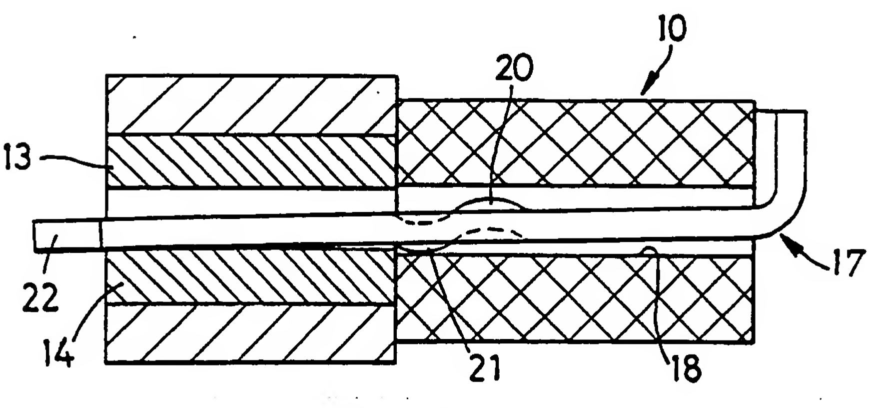

Fig. 3

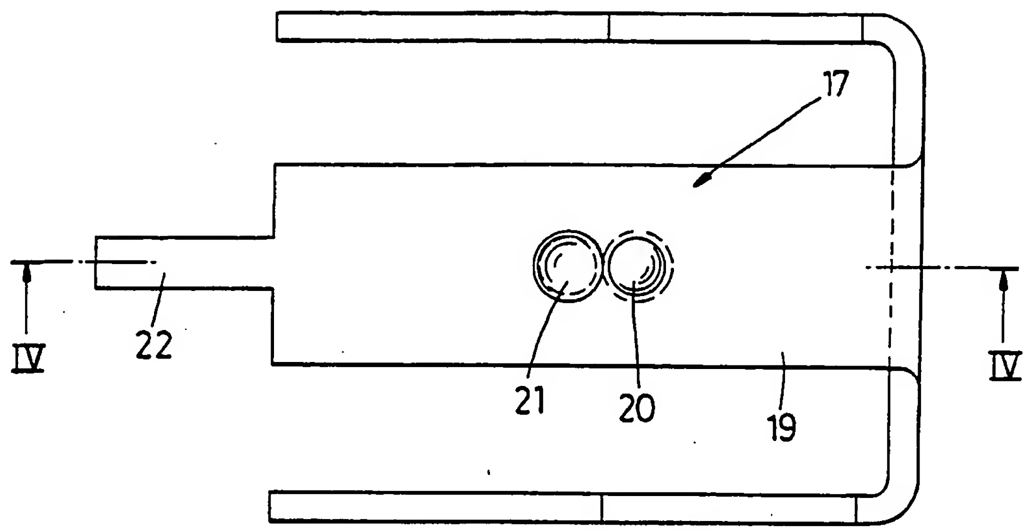

Fig. 4

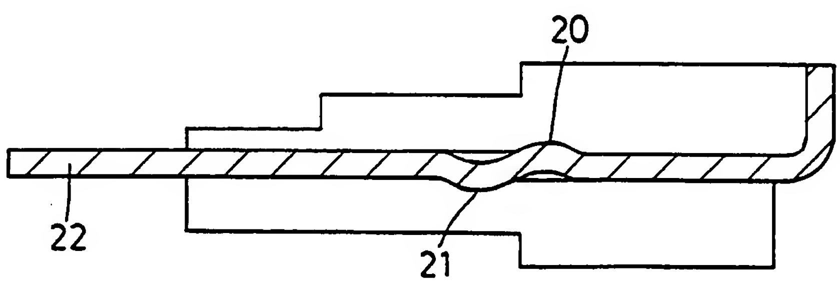

Fig. 5

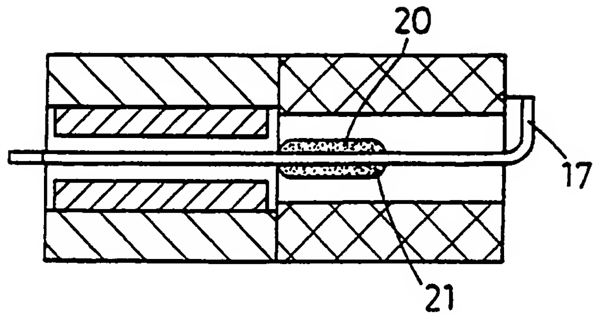

Fig. 6

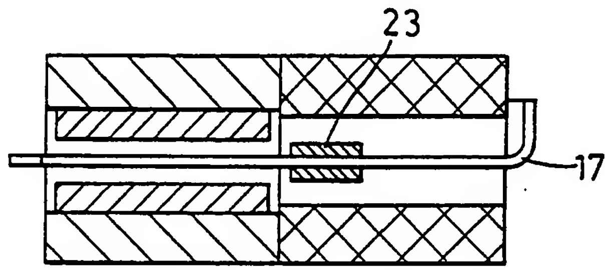

Fig.7

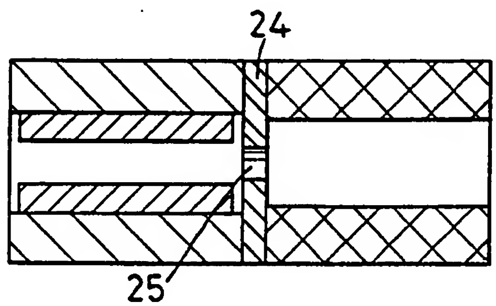

Fig. 8

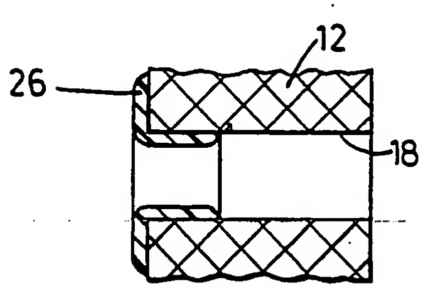

Fig. 9

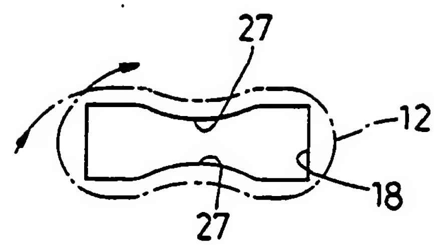

Fig. 10

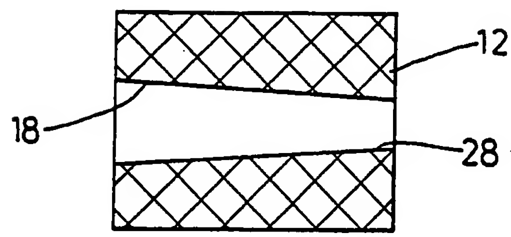

Fig. 11

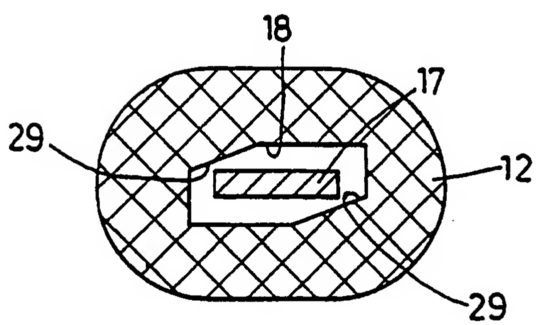

Fig. 12

Application No. (if known): 10/756589 Attorney Docket No.: 47161-00043USPT

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